REMARKS/ARGUMENTS

Claims 1-11 stand rejected by the Office Action of August 31, 2004. No claims have been cancelled or added. Claims 1, 3-7, 9 and 11 have been amended. Claims 1-11 remain in the application.

The examiner has not considered the Swedish language reference cited in the Information Disclosure Statement filed 12 March 2004 as Cite No. BA since a concise explanation of the relevance of the reference was not included. The reference is being resubmitted in a Supplemental Information Disclosure Statement filed herewith as Cite No. EA. The cover letter of the Supplemental Information Disclosure Statement provides a concise statement of the relevance of the reference as it is understood by the individual designated in 37 CFR 1.56(c) as most knowledgeable about the content of the information. Applicant requests that the examiner consider the reference and initial the list provided therewith to indicate that the reference has been considered.

Also, in regard to the Information Disclosure Statement filed March 1, 2004, the examiner has lined through Cite No. DG to indicate that the cited information was not considered. The examiner provided no reason for not considering the cited information. Applicant believes the information was presented in compliance with 37 CFR 1.97 and 1.98 and respectfully requests that the examiner consider the cited information or provide a reason why the information was not considered so that applicant may respond properly thereto.

The examiner states that the provisional application from which domestic priority is claimed under 35 USC 119(e) is claimed does not provide adequate support under 35 USC 112 for claims 1-11 of the application. The examiner further states that the

provisional application only teaches $Pb(Sc, Nb)O_3$ ordered along the [001] direction where the amount of niobium and scandium is modulated. Applicant respectfully traverses the examiner's statement for the following reasons.

The provisional application contains a detailed description of one species of the claimed invention. The species ($Pb(Sc, Nb)O_3$) is representative of the entire genus (heterovalent perovskite alloys ordered as recited) that is claimed in the present application. The provisional application further contains a description of the identifying characteristics of the claimed genus, namely that the claimed ferroelectric perovskite alloy having enhanced electromechanical properties may be obtained by ordering the atoms in stacked planes where the alloy is atomically ordered along a direction that is not the direction of polarization of the disordered alloy, the stacking is short, and the atoms belong to different columns of the periodic table (heterovalent). See paragraph **[0003]** of the provisional application. Further, the provisional application provides a detailed description of the underlying physical mechanism producing the enhanced effects sufficient for one skilled in the art to replicate the effects in structures other than the specific examples given in the specification. As stated in the Summary of the Invention on page 1, "...a certain class of atomic rearrangement should lead simultaneously to large electromechanical responses and to unusual phases in a given class of perovskite alloys. Our simulations also reveal <u>the microscopic mechanism responsible for these anomalies</u>." (Emphasis added.)

The basis for claiming perovskite alloys having atoms belong to different columns of the periodic table is fully described and enabled for one of skill in the art by the detailed example of the species comprising Niobium and Scandium and the detailed

physical basis for the enhanced characteristics of the ordered alloy. As noted in the specification of the provisional application in paragraph **[0017]** at page 9, the effects can be understood from electrostatic considerations, namely the difference in valence between the Niobium and the Scandium atoms. Such a difference in valence is a well known consequence of selecting atoms from different columns of the periodic table. Similarly, the "short" stacking period is well supported by the same paragraph of the specification on page 10 which explains that the enhanced characteristics of the ordered alloy occur at the borderline between the monoclinic and the orthorhombic phases, consistent with the ease of rotating the polarization. As noted, "[w]e have shown here the results for the thinnest possible structures. For larger structures, with thicker layers, the 'unusual' electromechanical responses will be smaller due to small internal electric fields." It is clear then that "short" has a clearly understandable meaning with respect to the enhanced physical properties of the described ordered alloy. The greatest effects are in the thinnest structures (4 stacked layers) and the effect become less pronounced in thicker structures. As to the ordering of the alloy in the [001] direction, the provisional application contains a detailed discussion of the physical mechanism by which the polarization of the alloy is rotated to produce the enhanced electromechanical effects. A phase change in a ferroelectric crystal may be accompanied by a rotation in the polarization of the crystal. See the discussion at paragraph **[0013]**. Large electromechanical effects may be found in the vicinity of such phase changes. The large electromechanical responses are the result of the rotation of the polarization. Paragraph **[0017]**, lines 25-26. By the ordering of the present invention, a large effect on the polarization is produced as a result of the internal

electrical field produced in the ordering direction. See generally, paragraph **[0017]**, particularly lines 3-7. If the ordering direction is in the direction of polarization, it is a direct consequence that no rotation of the polarization will occur since the effect of the ordering will be in the same direction as the polarization. On the other hand, it is also a necessary consequence of ordering in a direction that is not the direction of polarization, that the internal electric field will produce a rotation of the polarization and thus the enhanced electromechanical effects. This detailed explication of the physical effects set forth in the provisional application and the detailed mathematical equations that describe those physical effects provide ample support for one skilled in the art to both understand and replicate the noted physical effects in the claimed genus.

It submitted therefore that the written description in the provisional application provides adequate support for claims 1-11.

The examiner has rejected claims 1-11 under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Specifically, the examiner states that claims 1 and 9 are indefinite as to the actual number of A and B elements in the material since the listing of multiple A and B variables implies a minimum of three different elements are present, but the description in line 4 of each of claims 1 and 9 indicates that the minimum number of A or B is two. Claim 1 has been amended to clarify that the minimum number of A site atomic species is one and minimum number of B site atomic species is two. Claim 9 has likewise been amended to clarify that the minimum number of A site atomic species is two and the

minimum number of B site atomic species is one. Claims 3-7 and 11 have been amended to be consistent with the clarifying language of amended claims 1 and 9.

The examiner has also rejected claims 1-11 under 35 USC 112, second paragraph, as being indefinite in that claims 1 and 9 recite the term "short" to describe the stacking period. The examiner states that the specification does not provide a standard for ascertaining the requisite degree and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. The examiner's rejection is respectfully traversed for the following reason.

As noted above with respect to the examiner's statement that the provisional application does not support the claimed materials, the term "short" is well supported by paragraph **[0019]** of the specification on page 11 which explains that the enhanced characteristics of the ordered alloy occur at the borderline between the monoclinic and the orthorhombic phases, consistent with the ease of rotating the polarization. "We have shown here the results for the thinnest possible structures. For larger structures, with thicker layers, the 'unusual' electromechanical responses will be smaller due to small internal electric fields." It is clear then that "short" has a clearly understandable meaning with respect to the enhanced physical properties of the described ordered alloy. The greatest effects are in the thinnest structures (4 stacked layers) and the effect become less pronounced in thicker structures. Also, the examples set forth in the present application include both 4 plane stacks and 12 plane stacks. These examples, in combination with the detailed mathematical and physical explication of the conditions under which the enhanced electromechanical properties of the ordered alloy occur, provide ample understanding of the term "short" for one skilled in the art.

The examiner has rejected claims 1-11 under 35 USC 112, first paragraph, as failing to comply with the written description requirement in that the claims contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the claimed invention at the time the application was filed. The examiner states that the specification only teaches $Pb(Sc, Nb)O_3$ ordered along the [001] direction where the amount of niobium and scandium in each atomic plane is modulated and concludes that this teaching does not support the claimed materials. The applicant respectfully traverses the rejection for the following reasons.

The burden is on the examiner to show a prima facie case that the written description is not adequate. There is a strong presumption that an adequate written description of the claimed invention is present when the application is filed. The application contains a detailed description of one species of the claimed invention. The species ($Pb(Sc, Nb)O_3$) is representative of the entire genus (heterovalent perovskite alloys ordered as recited). The application further contains a description of the identifying characteristics of the claimed genus, namely that the claimed ferroelectric perovskite alloy having enhanced electromechanical properties may be obtained by ordering the atoms in stacked planes where the alloy is atomically ordered along a direction that is not the direction of polarization of the disordered alloy, the stacking is short, and the atoms belong to different columns of the periodic table (heterovalent).

The support for the claimed genus and ordering along a direction that is not the direction of polarization of the disordered alloy has been given above with respect to the examiner's statement that the provisional application lacks support for the claimed

invention. The arguments are set forth following with references to the equivalent paragraphs in the present application.

The basis for claiming perovskite alloys having atoms belong to different columns of the periodic table is fully described and enabled for one of skill in the art by the detailed example of the species comprising Niobium and Scandium and the detailed physical basis for the enhanced characteristics of the ordered alloy. As noted in the specification of the present application in paragraph **[0019]** at page 10, the effects can be understood from electrostatic considerations, namely the difference in valence between the Niobium and the Scandium atoms. Such a difference in valence is a well known consequence of selecting atoms from different columns of the periodic table. Similarly, the "short" stacking period is well supported by the same paragraph of the specification on page 11 which explains that the enhanced characteristics of the ordered alloy occur at the borderline between the monoclinic and the orthorhombic phases, consistent with the ease of rotating the polarization. As noted, "[w]e have shown here the results for the thinnest possible structures. For larger structures, with thicker layers, the 'unusual' electromechanical responses will be smaller due to small internal electric fields." It is clear then that "short" has a clearly understandable meaning with respect to the enhanced physical properties of the described ordered alloy. The greatest effects are in the thinnest structures and the effect become less pronounced in thicker structures. As to the ordering of the alloy in the [001] direction, the provisional application contains a detailed discussion of the physical mechanism by which the polarization of the ordered alloy is rotated to produce the enhanced electromechanical effects. A phase change in a ferroelectric crystal may be

accompanied by a rotation in the polarization of the crystal. See the discussion at paragraph **[0015]**. Large electromechanical effects may be found in the vicinity of such phase changes. The large electromechanical responses are the result of the rotation of the polarization. Paragraph **[0019]**, lines 25-26. By the ordering of the present invention, a large effect on the polarization is produced as a result of the internal electrical field produced in the ordering direction. See generally, paragraph **[0019]**, particularly lines 3-7. If the ordering direction is in the direction of polarization, it is a direct consequence that no rotation of the polarization will occur since the effect of the ordering will be in the same direction as the polarization. On the other hand, it is also a necessary consequence of ordering in a direction that is not the direction of polarization, that the internal electric field will produce a rotation of the polarization. This detailed explication of the physical effects set forth in the present application and the detailed mathematical equations that describe those physical effects provide ample support for one skilled in the art to both understand and replicate the noted physical effects in the claimed genus. The examiner has the initial burden of presenting evidence or reasons why persons skilled in the art would not recognize in the disclosure a description of the invention defined by the claims. As argued herein, the disclosure set forth in the specification clearly provides a description of the invention defined by the claims. The examiner has not therefore met the burden required for establishing a prima facie case that the written description is inadequate.

For these reasons, it is submitted therefore that the written description in the application provides adequate support for claims 1-11.

The examiner has rejected claims 1-11 under 35 USC 112, first paragraph, because the specification, while being enabling for $Pb(Sc,Nb)O_3$ ordered along the [001] direction where the amount of niobium and scandium in each atomic plane is modulated, does not reasonably provide enablement for any ferroelectric perovskite atomically ordered along a direction that is not the polarization direction. The examiner concludes that the specification does not enable any person skilled in the art to make the invention commensurate with the claims. The examiner's rejection is respectfully traversed for the following reasons.

As with the written description requirement, the examiner has the initial burden of establishing a prima facie case to support a rejection for non-enablement; i.e., that the application does not teach how to make and use the invention. As argued above, however, the application provides ample teaching for one skilled in the art to make and use the invention. In particular, the teachings in the specification provide clear direction as to making and using the invention for members of the claimed genus other than $Pb(Sc,Nb)O_3$ when the ordering is in a direction other than the [001] direction.

Since the examiner has failed to carry the burden of establishing a prima facie case of unpatentability, the rejection of claims 1-11 under 35 USC 112, first paragraph should be withdrawn.

The examiner has rejected claims 1, 3, 5, 7 and 8 under 35 USC 102(b) as being anticipated by the article by Park et al. (Cite No. CD). In particular, the examiner states that Park et al. teaches perovskite ferroelectric materials composed of stacked planes having as the B elements Zn and Nb or Ti, Zn and Nb. The applicant respectfully traverses the examiner's rejection for the following reasons.

Claims 1, 3, 5, 7 and 8 all contain the limitation of stacked planes where the composition of each plane is modulated. Park et al. does not teach stacked planes and does not teach modulating the composition of such stacked planes. As noted in the present application, such stacked planes may be grown by such means as pulse laser deposition techniques or by molecular beam epitaxy. By contrast, Park et al. discloses growing single crystals by means that are clearly incompatible with forming such stacked planes. Paragraph III.A. on page 1806 of Park et al. describes growing crystals by mixing powders and placing them in a crucible. After heating, the mixture is slowly cooled to form crystals. Such a process is clearly not amenable to formulating stacked planes where the planes are modulated in composition. Park et al. simply does not disclose stacked planes or modulating the composition of stacked planes.

Since Park et al. does not disclose an element of the claims, Park et al. does not anticipate claims 1, 3, 5, 7 and 8.

The examiner has rejected claims 1, 3, 7 and 8 under 35 USC 102(b) as being anticipated by the article by Bellaiche et al. (Cite No. CL; Examiner's Cite No. V, first page of PTO-892). In particular, the examiner states that the article by Bellaiche et al. teaches a lead perovskite material ordered along the [001] direction and having stacked planes where the B elements are Ti and Zr. The applicant respectfully traverses the examiner's rejection for the following reasons.

Claims 1, 3, 7 and 8 all contain the limitation of stacked planes where the composition of each plane is modulated. The article by Bellaiche et al. does not teach stacked planes and does not teach modulating the composition of such stacked planes. In Bellaiche et al., the subject under consideration is a particular perovskite having the

composition $Pb(Zr_{0.5}Ti_{0.5})O_3$. See, e.g., lines 35-36 on page 7878, which states "[u]sing $Pb(Zr_xTi_{1-x})O_3$ with x=0.5 for our test system..." Bellaiche et al. does not disclose or teach modulated stacked planes but rather a homogenous crystal having a uniform composition for its test system.

Since Bellaiche et al. does not disclose an element of the claims, Bellaiche et al. does not anticipate claims 1, 3, 7 and 8.

The examiner has rejected claims 1-5, 7 and 8 under 35 USC 102(b) as being anticipated by the article by Al-Barakaty et al. (Cite No. DF; Examiner's Cite No. X). The applicant respectfully traverses the examiner's rejection.

The article by Al-Barakaty et al. is shown on its face as having been published on September 23, 2002. The filing date of the provisional application from which the present application claims domestic priority is August 8, 2002. The article by Al-Barakaty et al. is therefore dated after the filing date of the provisional application and therefore cannot anticipate it. As argued above, the provisional application supports the claims of the present application. Even if the provisional application did not support the claims of the present application, the filing date of the present application is August 1, 2003. This date is within one year of the date of the article by Al-Barakaty et al. and therefore the article cannot anticipate the present application even without the benefit of the filing date of the provisional application.

The examiner has rejected claims 1 and 3-8 under 35 USC 102(b) as being anticipated by the article by George et al. (Cite No. DA; Examiner's Cite No. W). In particular, the examiner states that this article teach a lead perovskite ferroelectric

material having 12 plane stacks and having Sc and Nb as the B elements. The applicant respectfully traverses the examiner's rejection for the following reasons.

Claim 1 and 3-8 all recite the following element: "...said specific temperature being selected from any temperature less than the Curie temperature of the disordered alloy." The article by George et al. does not suggest that a perovskite alloy that is stacked in modulated planes as claimed can be produced with enhanced electromechanical properties at any temperature below the Curie temperature. The recited element was first confirmed by the present inventors and disclosed in an article in Nature entitled "Anomalous properties in ferroelectrics induced by atomic ordering" dated September 6, 2001. (Cite No. CY, last complete paragraph on page 56; also see specification, paragraph **[0018]**). Since an element of the claims is not taught by the George et al. article, the claims are not anticipated thereby.

The examiner has rejected claims 1-8 under 35 USC 102(b) as being anticipated by the abstract and slides of the presentation given in February 2001 (Cite Nos. CU, DE; Examiner's Cite No. U, 2nd page). Similarly as argued above with respect to the previous rejection, claims 1-8 all recite the following element: "...said specific temperature being selected from any temperature less than the Curie temperature of the disordered alloy." The abstract and slides do not suggest that a perovskite alloy that is stacked in modulated planes as claimed can be produced with enhanced electromechanical properties at any temperature below the Curie temperature. The recited element was first confirmed by the present inventors and disclosed in the article in Nature cited above. (Cite No. CY, last complete paragraph on page 56; also see

specification, paragraph **[0018]**). Since an element of the claims is not taught by the cited abstract and slides, the claims are not anticipated thereby.

The examiner has rejected claims 1-8 under 35 USC 102(a) as being anticipated by the George Thesis (Cite No. CS; Examiner's Cite No. V, 2nd page of PTO-892). The applicant respectfully traverses the examiner's rejection.

As shown in the attached Rule 131 Affidavit, the present invention is shown to have been completed by a date no later than September 6, 2001, which antedates the cited George Thesis. Therefore, the George Thesis does not anticipate the claims of the present application under 35 USC 102(a).

The examiner has rejected claims 1-8 under 35 USC 102(f) because the applicant did not invent the claimed subject matter. The examiner states that the thesis and presentation in February 2001 raise the question as to who is the actual inventor of claims 1-8: George, George and Bellaiche, or George, Bellaiche and Iniguez. The examiner's rejection is respectfully traversed for the following reasons.

As shown in the attached Rule 131 Affidavit, the invention was made jointly by Bellaiche, George and Iniguez.

For the reasons stated above, claims 1-11 should be allowable. Reconsideration and allowance of the claims is, therefore, respectfully requested.

Respectfully submitted,

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